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COMPUTER-MANAGED INSTRUCTION IN THE NAVY: V. THE EFFECTS OF CHARTED FEEDBACK ON RATE OF PROGRESS THROUGH A CMI COURSE

NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER
San Diego, California 92152

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COMPUTER-MANAGED INSTRUCTION IN THE NAVY: V. THE EFFECTS OF CHARTED FEEDBACK ON RATE OF PROGRESS THROUGH A CMI COURSE

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Computer-generated progress charts were developed to provide feedback to students under computer-managed instruction. The effect of cumulative progress information on course completion time and achievement was determined through two experiments. In Experiment I, involving civilian researchers, BE/E students experienced five different conditions of charted feedback. A standard BE/E learning center served as control. Although no significant differences in completion times were found, student and instructor attitudes were strongly supportive of the chart procedures. Experiment II

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operationally applied the best procedure from Experiment I, chart-on-demand, at four CMI schools. Versions of charts for instructor use were also employed. In all four schools, students using the chart procedures completed the course in shorter time than did control students. Student and instructor attitudes toward the charts were again extremely supportive. The faster training time by students indicates the potential for significant training cost savings by widespread use of the feedback charts in Navy CMI courses.

FOREWORD

This research was performed under work unit Z1176-PN.01 (Improving the Navy's Computer-managed Training System), as part of an R&D project aimed at improving the Navy's operational computer-managed instruction (CMI) system. It was sponsored by the Deputy Chief of Naval Operations (OP-01).

This report is the last in a series of five on Navy CMI. Previous reports have described the problem areas that limit the effectiveness of the CMI system and the R&D plans that have been developed to address these problem areas (NPRDC SR 80-33), the effects of two student/instructor ratios on student performance and instructor behavior (NPRDC TR 81-6), the effects of automated performance testing on testing and training time at the Radioman "A" school (NPRDC TR 81-7), and the effects of test item format on learning and knowledge retention (NPRDC TR 81-8). This report discusses the benefits from computer-generated feedback charts that display information on cumulative student progress as a motivation factor in CMI. Results of the CMI research will be used by the Chief of Naval Education and Training, the Chief of Naval Technical Training, commanding officers of all the Navy CMI schools, and others concerned with computer-based instruction.

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SUMMARY

Problem

Although the individualized instruction provided by the Navy's computer-managed instruction (CMI) system allows students to progress according to their ability, a strong motivating mechanism is needed to ensure that students meet predicted course completion schedules. Any innovation that improves student progress rates has the potential to reduce training time and costs. Various incentives to improve achievement have been introduced in Navy training schools, but fully effective methods for motivating students in CMI courses are still needed.

Objectives

The objectives of this research were to (1) develop feedback charts that display information on cumulative progress to motivate students, (2) determine the best procedures for chart delivery, and (3) assess the feasibility of the chart procedures in operational CMI courses.

Approach

The approach for this investigation involved conducting two experiments. Experiment I was designed to test five types of chart conditions in one CMI course. Experiment II was an operational test of the best chart procedure from Experiment I in four CMI schools with varying content and management styles.

Results

Experiment I yielded no significant differences between the five chart procedures in terms of actual course completion times. The best chart method appeared to be the condition in which students requested charts that contained indications of available incentives. Student and instructor attitudes toward the chart procedures were strongly supportive. Students rated the desirability of several possible incentive options. A special service ribbon for academic accomplishment was highly rated by students as an incentive option.

Experiment II was conducted in operational CMI learning complexes in the following four schools: Basic Electricity and Electronics, Great Lakes and Memphis, Propulsion Engineering Basics, and the Radioman "A" School. In all four schools, the chart procedures resulted in shorter course completion times when compared to completion times of control students in normally operated complexes without the charts. Again, the student and instructor attitudes were strongly supportive of the effectiveness of the chart procedures.

Conclusions

Charted feedback of progress in a CMI course is effective for improving student progress without interfering with achievement.

Recommendations

The Chief of Naval Education and Training should (1) implement the incentive chart procedures into CMI courses as a part of any effort to upgrade the CMI system, and (2) investigate the feasibility of establishing a special service ribbon to be used as an incentive for superior training accomplishment.

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INTRODUCTION

Problem

One reason why the Navy introduced computer management of instruction was to accommodate varying rates of student progress through technical training courses. However, the individualized instruction process associated with computer-managed instruction (CMI) can be degraded by poor motivation of students, who are responsible for their own progress. Although both negative and positive incentives are provided to encourage students to complete courses ahead of their predicted completion times, students are not always aware of their progress status. The CMI system needs a method of providing progress feedback to students in technical schools to improve their progress through CMI courses.

Background

The problem of charting the course-related activities of students enrolled in self-paced college courses has received some attention (Hursh, 1978; Glick & Semb, 1978). Although students are allowed to proceed at their individual pace in these courses, they are constrained by academic calendar units (quarters or semesters). Freed of external checks, many students procrastinate until they fail to meet the completion date. Successful incentives to motivate students include bonus points for on-schedule completion (Bitgood & Keech, 1971; Bitgood & Segrave, 1975; Lloyd, 1971), limiting the time that materials are available (Heckler, 1976), and progress charts (Semb, Conyers, Spencer, & Sanchez-Sosa, 1975). An evaluation is needed of the potential effectiveness of progress charts in Navy training settings.

Progress charts allow students to compare their daily actual progress rates with predicted rates (Figure 1 shows a predicted-rate plot). The Air Force, in a variation of this technique, uses manually-generated predictions to individualize suggested progress rates. The Air Force requires students to maintain their own charts and has developed a training module to provide instruction in this skill. McCombs, Dobrovolny, and Judd (1979) reported that these time-management procedures yielded significantly shorter training times.

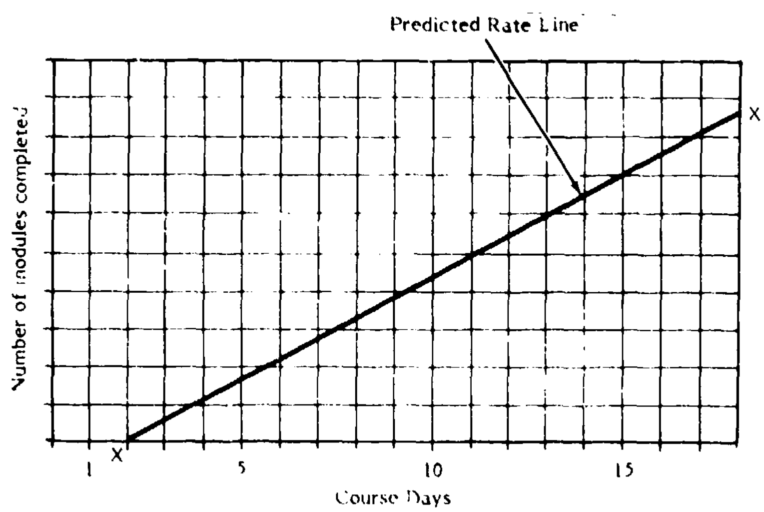

Figure 1. Predicted Progress Rate--sample progress chart showing the predicted rate line (adapted from Semb et al., 1975).

The Navy CMI computer routinely provides the data from which student progress can be predicted. A system of multiple-regression equations has been developed that relates education history data and Armed Services Vocational Aptitude Battery (ASVAB) scores to completion times. By inserting the individual values of these variables into the equation, completion time for each terminal learning objective (TO) or instructional module within the course can be predicted. The sum of these TO times is a predicted completion time (PCT), expressed in hours, for the entire CMI course. At any point in the course, a learning rate (LR) can be computed as the ratio of the time actually spent divided by the predicted time (actual time ÷ predicted time). This quotient indicates whether the student is ahead of or behind schedule--values greater than 1.0 indicate the student is behind schedule; and values less than 1.0, ahead of schedule. To determine a student's progress rate (PR) toward the original predicted graduation day, the actual time is credited with time spent in extra study.

The PR is sensitive to all of the student's efforts to stay on schedule, because it considers as actual time only the daily 6-hour blocks of time when the student is present in a CMI learning center. Since students can improve their PR by study during off-hours, LRs are always equal to or greater than PRs. The difference reflects the amount of extra effort the student expends to remain on schedule. These numerical ratios, along with other descriptive information, are provided daily to aid instructors in spotting students who are having problems and beginning to fall behind schedule.

Anecdotal evidence suggests that sharing these ratios with students, in conjunction with use of an informal incentive system, can reduce course completion time. However, many Navy instructors feel that, if students are shown the displays, they become overly sensitive to time factors to the detriment of learning. Despite the reservations of some instructors, the Basic Electricity and Electronics (BE/E) School, Memphis, began printing predicted and actual times on the learning guide statements students receive after completing a test. Although the statements included predicted and actual TO completion times, they did not provide cumulative overall progress or the information necessary to compute such progress and did not list the criteria for incentive awards.

Data covering the months immediately before and after this innovation showed no difference in completion times. These results, in conjunction with those in available literature, suggest that PR data should be graphically displayed cumulatively, as in Figure 2. This would allow students to forecast progress and see clearly how better study habits could accelerate progress and ensure that they complete the course on time.

Objectives

The objectives of this research were to (1) develop computer-generated feedback charts that display information on cumulative progress to motivate students to increase effort, (2) determine the best procedures for chart delivery, and (3) assess the feasibility of the chart procedures in operational CMI courses.

APPROACH

This investigation involved two experiments. The first experiment, conducted at one CMI school, was designed to determine experimentally the best method for delivering charted progress information. The second experiment, conducted at four CMI schools, was designed to assess the operational feasibility and generalizability of the best chart delivery method identified in Experiment I, across a range of course content and school management styles.

EXPERIMENT I

CMI Course

The BE/E School, Memphis, was selected for the investigation of incentive charts to promote student progress under CMI. BE/E is ideal for an investigation of incentive variables for several reasons:

1. Since school attendance occurs early in the technical training series, students include those whose inherently poor motivation to learn has not yet eliminated them from the training system.

2. Since BE/E is the largest training course, enrolling about 25,000 students annually, an effective technique at BE/E would result in greater benefits--reduced costs and training time--than could be obtained from a course with fewer students.

3. The chart procedures introduced in BE/E could be implemented immediately in advanced courses for which BE/E is a prerequisite, with no reintroduction being necessary. If charts were to become a regular feature of CMI, students should become familiar with them in their first CMI course. This is the point in their training at which they learn the basic mechanics of interacting with the computer.

The test sites were two BE/E learning centers, each housing 50 student carrels and a 10-carrel central test section. Thus, testing and learning occurred in the same physical space. Each complex contained an optical scanner for entering test data and a General Electric (GE) terminet for printing student learning guides.

Materials

The course materials were Modules 1-14 of Coursefile (CF) 70 comprising 32 TOs. Predicted completion times were available for each TO. The student had to achieve 100 percent mastery on tests for each TO before moving to the next. Remedial tests were assigned as necessary. Before graduating, all students had to pass a comprehensive examination with at least a 70 percent score. Time required to take and pass the comprehensive examination was not included in training completion times.

Chart Development

Three basic requirements influenced the progress display format (Johnston & Pennypacker, 1980):

1. Progress data must accurately show how far the student is ahead of or behind schedule at any selected time.

2. The display must be sufficiently sensitive so that small gains are immediately visible to the student.

3. The data must be spread over enough time so that the student can project his progress and, if necessary, alter his study tactics to meet or exceed projected completion dates.

In the first steps toward developing an effective chart, several variations of the cumulative progress chart used by Semb et al. (1975) and the Air Force were tested on historical data from the Management Information and Instructional Systems Activity

(MIISA) computer files. None of the chart versions tested had both the necessary range and sensitivity.

Navy instructors often treat the CMI daily tabular progress report as a chart by tracing PR values as though tracing points on a graph. Accordingly, the new charts were designed to display the PR values as a function of TO rather than as a linear function of time. Such a display was expected to be more acceptable to instructors and students because it resembled data already in use. The coordinates of the plotted points were the TO that was just completed and the cumulative progress rate to that point, defined as the sum of the actual study hours minus extra study hours divided by predicted hours. The predicted value was displayed as a horizontal line at the 1.0-level ordinate. Therefore, points below this line indicated that the student was ahead of schedule; and those above, behind schedule.

The problem remained of developing an ordinate that would exhibit both sufficient range and sensitivity. It was found that a two-cycle logarithmic scale with _e_ as the base could accommodate all but a tiny fraction of observed cases with adequate sensitivity near the modal values around 1.0. Therefore, the resulting chart format, which is shown in Figure 2, was a two-cycle semi-logarithmic chart with PR values from .37 to 2.72 on the ordinate, where the midpoint is 1.0 (the expected PR value), and the TO numbers are on the abcissa (Figure 2). Also shown in Figure 2 are the incentives at designated ordinate values. This incentive information was not shown to all students. However, when it was used, it served as a constant reminder of the available incentives and the student's position in relation to them. The vertical line at TO 10 represents the point at which students began receiving and using the .

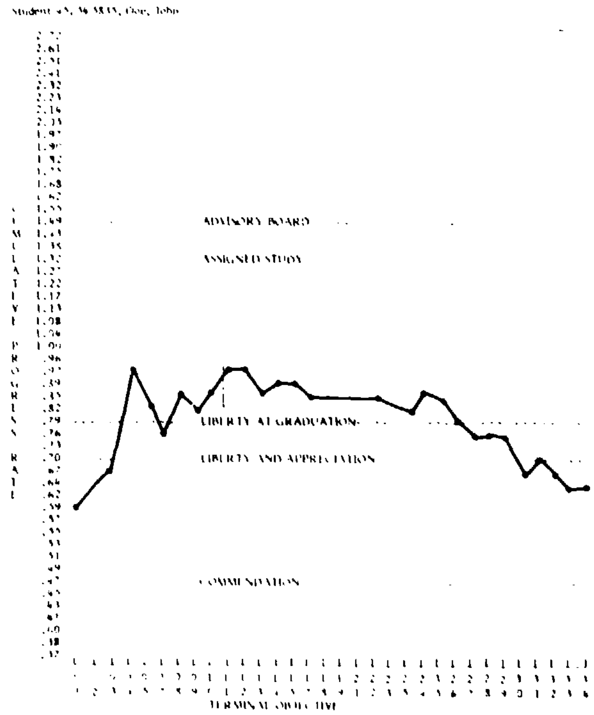

Figure 2. Student CMI progress chart showing available incentives and hypothetical data.

Chart Delivery

To prevent the research activities from impeding regular training operations, production of the charts had to be automated, with delivery occurring at approximately the normal rate of student interaction with the CMI system. It was not practical to use the CMI central computer because of cost, delays, and interference with other instruction functions. Thus, an IBM 5110 system was programmed to maintain records duplicating those in the central computer and to generate charts, complete with data points, of the type shown in Figure 2.

To ensure compatibility with the larger system, the printing capabilities of the IBM 5110 were limited to those of the GE terminets, and the same paper was used. Each chart had 56 lines of print and was printed in 10 to 50 seconds, depending on the number of points to be computed. Input, filing, retrieval, computing, and plotting routines were written in the APL computer language.

Subjects

Subjects were 120 BE/E students (91 Navy and 29 Marine Corps personnel). Subject ratings are shown in Table 1.

Table 1

Ratings of Subjects for Experiment I

Rating	N
Aviation Antisubmarine Warfare Technician (AX)	4
Aviation Electrician's Mate (AE)	39
Aviation Electronics Technician (AT)	43
Aviation Fire Control Technician (AQ)	6
Aviation Support Equipment Technician (Electrical) (ASE)	1
Aviation Ordnanceman (AO)	6
Avionics Repairman (AVR)	13
Tradevman (TD)	8
Total	120

Seventy-one students in one complex were randomly assigned to one of four experimental groups, with each group receiving the charts the under different specified conditions:

1. Group CC (Constant Chart) (N = 16)--Students received a chart at the completion of each TO, beginning with TO 10.

2. Group CS (Self-chart) (N = 21)--At the end of TO 10, students received a chart portraying their progress to that point. They also received special instructions (Appendix

A, p. A-4) on how to plot their progress rate. Thereafter, only data coordinates necessary for the students to plot their own progress were provided at the completion of each TO.

3. Group CD (Chart on Demand) (N = 21)--Students received a cumulative progress chart at the end of TO 10. Thereafter, charts were provided on student demand.

4. Group CY (Chart Yoked to Demand (N = 13)--Students received a cumulative progress chart at the end of TO 10 and thereafter on a random basis. Each CY student was matched with a CD student. Thus, each time the CD student requested a chart, the computer automatically delivered one to the CY student. The only difference between the two groups was that the CD student requested the chart when he felt he needed it, and the CY student received it regardless of his perceived need. CY yoking was not initiated until several CD students had completed the course, so a complete history of CD chart requests was available for computer yoking of CY students.

Near the end of data collection, 11 additional students were randomly assigned to a fifth experimental group--Group CDI (Chart on Demand with Incentive). This group followed the CD group procedure, requesting charts as needed. However, the charts received on request had the incentive printed at the appropriate progress level (Figure 2) to test the effect of charted feedback and incentive reminder.

The remaining 38 students in another complex constituted the control group. These students began the course during the conduct of the experiment, completed the course before data collection ended, and signed a release allowing their data to be used in the analysis. The control group was not formally informed of the research in progress, although proximity to the site and association with the research subjects probably made them aware of the exercise.

Procedure

During the first day in the learning center (LC), a student registered, received study materials, and attended an introductory session at which the LC instructor explained procedures and introduced the civilian research team member. Volunteers for the study were solicited (all but one student agreed to participate) and were issued preliminary instructions (Appendix A, p. A-1). The computer generated student assignments for experimental conditions and created a data file that included the 32 predicted TO completion times obtained from MIISA.

At the end of TO 10, the computer automatically printed a progress chart. Instructions appropriate to the assigned experimental condition (Appendix A, p. A-2) were given to the student, the chart was explained, with special emphasis on interpretation of progress to date, and the course was continued. As indicated previously, students in Group CS received additional instructions (Appendix A, p. A-4).

Regardless of the experimental condition to which a student was assigned, at the completion of each TO, the 5110 computer printed the actual time required to complete that TO and the time predicted for the next one. This predicted time was purposely omitted from the learning guides to ensure that the student passed by the data collection site to obtain this information. At the end of the course, students took a comprehensive BE/E examination before being assigned to a follow-on school or to a new duty station.

At the end of the experiment, the 8 participating instructors and the 82 students in the experimental groups answered a brief questionnaire designed to obtain their opinions on the value of the experimental materials and the procedures.

Data Analysis

The plan for the data analysis consisted of determining the initial equivalency of the five experimental groups and one control group by performing a one-way analysis of variance (ANOVA) on the predicted overall completion times. If there were no significant differences, the groups could be considered equivalent, and the effect of the charting procedures could be determined by performing a similar one-way ANOVA on the actual course completion times. If the groups were not equivalent, then the differences could be controlled statistically by using an analysis of covariance (ANCOVA) with the predicted completion times being the covariate.

Results

Course Completion Times

Table 2 presents the mean predicted and actual completion times for the six groups. The one-way ANOVA performed on the predicted times was not significant ($F = .523$, $df = 5, 114$, $p > .05$). This indicates that the groups are equivalent and confirms the use of the ANOVA on the actual completion times to determine the effects of the chart procedures. Here again, the ANOVA revealed no significant differences among the six groups ($F = .737$, $df = 5, 114$). In case the effect of the charts was masked due to differential predicted completion times that were not detected by the ANOVA, an ANCOVA was performed using the predicted times as the covariate and the actual times as the dependent measure. This analysis also revealed no significant differences ($F = 1.425$, $df = 5, 114$). While this overall finding did not pinpoint a statistically superior chart procedure, comparing individual chart groups means with the mean for the control group, along with other factors, suggested the need for further chart procedure evaluation. For example, the combined mean for the two demand groups (CD and CDI) was 92.0 hours, 10.7 hours less than the mean for the control group--well over 1 full training day. Since the CDI group required less completion time than did the other groups, the chart on demand with incentive indicators procedure was selected for use in Experiment II. Also, this procedure was positively supported by students and instructors and promised to reduce training time significantly.

Table 2

Group Mean Predicted and Actual Completion Times and Test Scores

Group	Mean Predicted Completion Time (Hours)	Mean Actual Completion Time (Hours)	Mean Comp. Test Score
Constant Chart (CC) (N = 16)	102.6	98.5	79.81
Self Chart (CS) (N = 21)	106.2	105.3	79.74
Chart on Demand (CD) (N = 21)	104.1	94.7	81.67
Chart Yoked to Demand (CY) (N = 13)	98.1	96.9	77.80
Chart on Demand with Incentive (CDI) (N = 11)	105.3	87.2	82.50
Control (N = 38)	101.2	102.7	81.00

Comprehensive Test Scores

To assess the effect of the chart procedures on overall course achievement, an ANOVA was performed on the final comprehensive test scores, which are also provided in Table 2. The ANOVA results indicated no significant differences in mean scores across the chart and control groups ($F = 0.664$, $df = 5, 114$). In other words, as a group, the students performed equally well in all conditions on the comprehensive end-of-course test.

Attitudes

Attitudes about the chart procedures were assessed by means of a brief questionnaire. Since many of the students were reassigned immediately after finishing the course, completed questionnaires were available from only 67 of the 82 experimental students. The overwhelming majority of the respondents indicated that they liked and understood the progress charts. Students also indicated that the charts would be a good way for instructors to follow student progress and that the charts should be placed in all CMI courses. Conversations with instructors confirmed this idea: They indicated the desire to have the charts available to them and to have additional information such as student progress data on an individual module basis.

In a final questionnaire item, students were asked to divide 100 points between various incentives in an effort to determine the relative values of incentives that could be offered. As shown in Table 3, students assigned the highest rating to the letter of commendation. The frivolous incentive that was included--free beer and dancing---received only 3.2 points, which suggests how seriously students view the incentives. The predominant entry in the "other" category was the satisfaction of having mastered the course content. For some students, tangible incentives are not necessary in a genuine learning experience.

Table 3

Incentives and Mean Assigned Point Values

Incentive	Mean Assigned Point Values
Letter of Commendation	30.5
Day of Liberty	19.5
Ribbon for Academic Distinction	17.7
Letter of Appreciation	13.2
Other	8.1
Special Graduation Certificate	8.0
Free Beer and Dancing	3.2
Total	100.2

The suggested incentive of a special decorative ribbon for academic achievement was assigned 17.7 points, compared to 13.2 for an existing incentive, a letter of appreciation, and 19.5 for a day of liberty. Since service ribbons clearly are seen as valued forms of visible recognition, they should be considered when contemplating additions to training incentives.

Although instructor enthusiasm was somewhat more restrained than that of the students, seven out of eight instructors endorsed the proposal to add charts to the system. Six of the eight instructors favored having ready access to progress data in chart form. As the study progressed, some instructors became quite skilled at using the charts as an aid when advising on study tactics and special problem areas.

EXPERIMENT II

As indicated previously, Experiment II was conducted to determine how well the chart procedures work in an operational CMI setting. This experiment was conducted in four CMI schools, each with its own subject matter and management style, using the Navy CMI computer, and with no civilian researchers present.

CMI Courses

CMI courses selected for this experiment were those conducted at the BE/E Schools, Great Lakes and Memphis, the Propulsion Engineering (PE) Basics School, Great Lakes, and the Radioman "A" School, San Diego. These courses differed in content and management style but permitted a relatively low-cost research effort through some common locations. A fifth school was to be used in the experiment but time limitations prevented collecting adequate data from that school. The charting procedure used was the chart on demand with incentive. Although the same chart procedures were implemented in all four schools, physical constraints and management prerogatives did influence the precise manner in which the procedures were carried out. These differences will be discussed in the section on chart delivery.

For each school, the test site involved all students in an entire learning complex. A complex is typically comprised of from three to five learning centers (LC), with each LC being made up of 20 to 30 students managed by a learning center instructor (LCI). In some complexes, study and testing occurred in the same location. In other complexes, a separate LC was designated just for testing. Each complex had the normal allotment of one optical scanner and one GE terminet for regular CMI system interactions. In addition, for this experiment, an extra GE terminet was provided for the generation of the incentive charts. The CMI system computer software had been specially modified by MIISA to permit chart production at the extra terminets with complete up-to-date student progress information.

Materials

The course materials included the textbooks, manuals, and equipment normally used with each course. The only special materials for this experiment were a sign designating the extra terminet for "Chart Use Only," a one-page student instruction form describing the charts and how to get them, two pages of instructions about the charts for the instructors, and the charts themselves.

Chart Development

The chart developed for student use evolved from the one used in Experiment I, with modifications to suit the operating requirements of the conventional CMI equipment.

Figure 3, which provides a sample of this student cumulative progress rate chart, shows that it includes four incentive indicating lines: (1) review for Academic Review Board (ARB), (2) deficient progress--mandatory quiet study (MQS) recommended, (3) excellent progress, and (4) outstanding progress. While each school could choose where on the chart ordinate to locate these incentive lines, they were generally located close to the following points, respectively: 1.50, 1.25, 0.80, and 0.50.

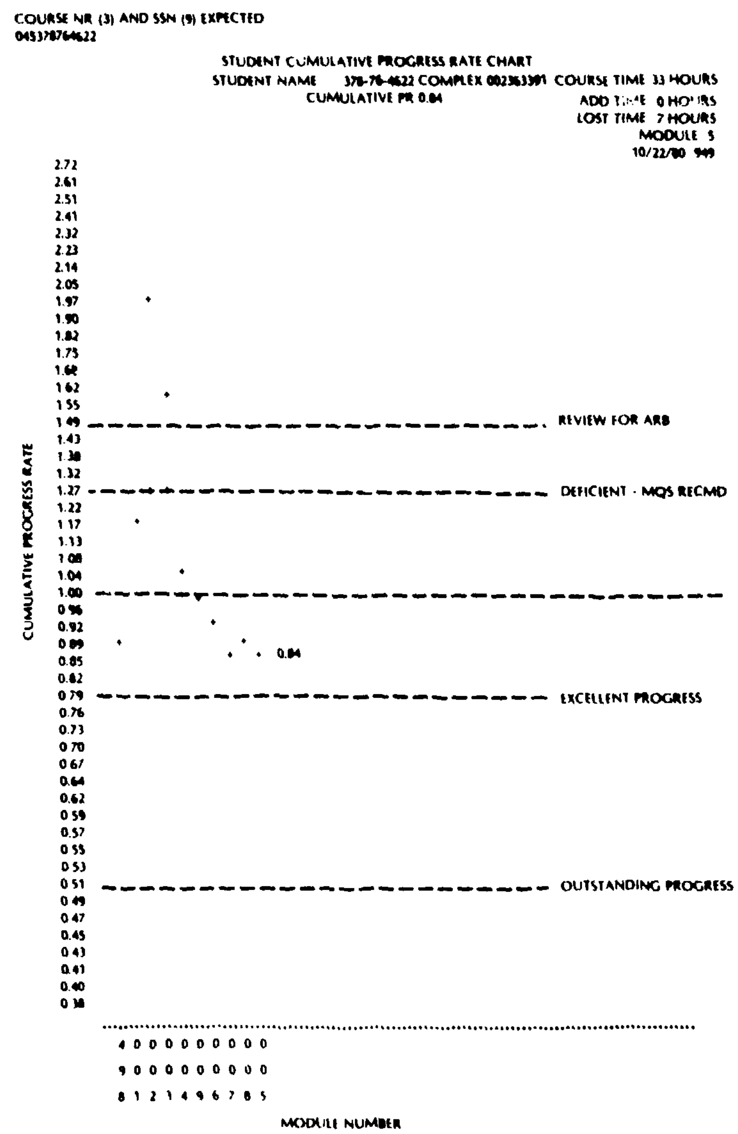

Figure 3. Student cumulative progress rate chart.

From interactions with instructors during Experiment I, it was learned that a different kind of chart for the instructors might also prove beneficial. The instructors not only wanted to know about the student's cumulative progress but also about his progress on each individual module. This information was useful when diagnosing student problems.

Accordingly, an individual module progress chart for instructors was developed and is shown in Figure 4. From this chart, an instructor can see how the student performed on each module in terms of actual progress compared to predicted progress for that module. Two versions of the instructor chart were available. One version presented data only for the last 20 modules completed, and the other version included a printout of all course data for that student.

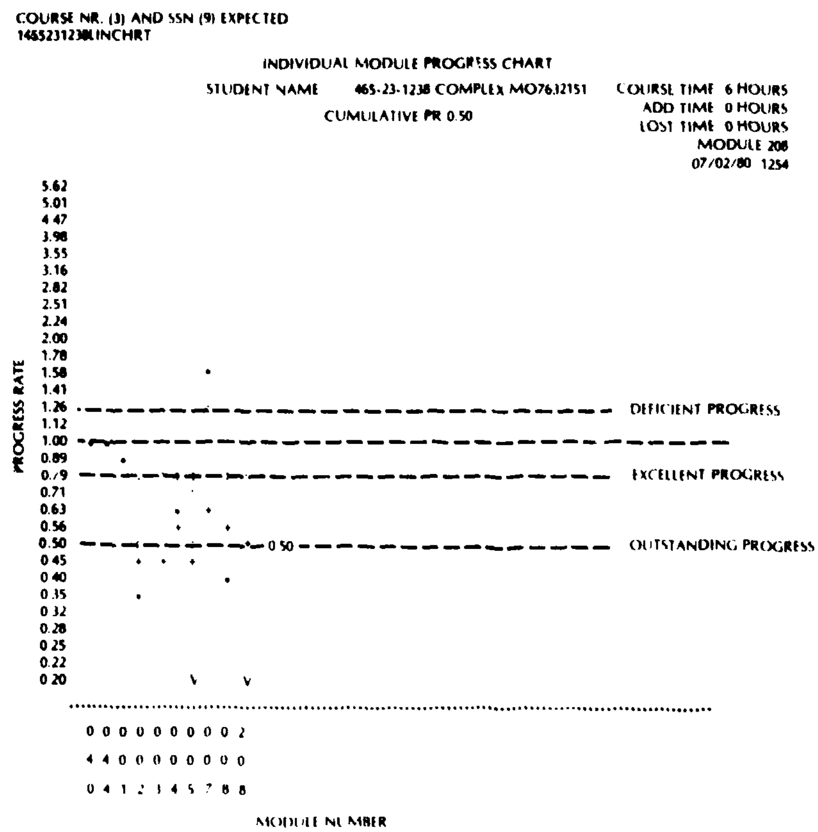

Figure 4. Individual module progress chart. Note: Individual module progress rates (PRs) are indicated by an asterisk. The last six data points of a cumulative PR line are shown by plus (+) signs.

Chart Delivery

For all courses, the charts were delivered from the CMI system by means of the extra terminet located in the complex. In the ideal delivery situation, the students would request charts by manipulating the terminets themselves; however, this procedure was not allowed at the BE/E School, Great Lakes. Consequently, at that school, the student requested the chart from the instructor, who then obtained the appropriate chart from the terminet. An additional difficulty encountered at the BE/E School, Great Lakes, was that an extra terminet was not available. As a result, the instructor had to perform additional entries into the regular terminet in order to obtain the chart. This requirement certainly increased the difficulty of getting charts and probably reduced the number of charts requested by the students. If these procedures were considered for system-wide implementation, additional computer software modifications could be made to eliminate

the need for the extra terminets and to simplify the method for requesting a chart from the computer.

Subjects

Subjects for this experiment included all students who were randomly assigned to the designated chart complexes after a specified date and who completed the course during a 3-month period. For all schools, this provided 568 chart students. This timing method for subject selection meant that initially there were students in each complex who were not participating in the study. Brief observation and discussions with instructors revealed that this posed no problem.

Control subjects included all 657 students who were assigned to different complexes that operated without the charts under normal school procedures during the same time period. Data were obtained for the control group students from the CMI system. The control complexes selected were as similar as possible to the chart complexes, except for the use of the charts.

Sample sizes for chart and control groups at each school are provided in Table 4.

Table 4

Sample Size for Cha[illegible] and Control Groups
Expe[illegible]

School	Number of Students	
	Chart Groups	Control Groups
BE/E, Great Lakes	58	99
BE/E, Memphis	199	268
PE School	191	176
Radioman "A"	120	114

Procedure

Operational CMI procedures were used in the learning complexes as much as possible during this experiment. Researchers rarely entered the chart complexes and then only to interact with the Navy instructors to verify the use of proper procedures. Instructors for the chart complexes were volunteers who received about 2 hours of instruction on the use of the charts. After the start of the investigation, the instructor told each student who registered in the CMI complex about the charts and gave him or her the one-page student chart instruction sheet. The students were permitted to obtain their first charts after they had completed the second module in the course. They could obtain new charts only after completing another instructional module and then only upon request. Instructor charts were available only to the instructors and at their discretion. At the end of the data collection period, three schools, all but Propulsion Engineering Basics, continued using the chart procedures until computer system problems necessitated termination of chart generation.

Data Analysis

The data analysis plan for Experiment II duplicated that of Experiment I. For each school, the mean predicted course completion times were compared for the chart and control groups. If the groups were determined to be statistically equivalent, the effect of the charts was assessed by comparing the mean actual course completion times. Since each school only had two groups, and each school had its own independent course schedule, separate t-tests were used.

Results

Course Completion Times

Table 5, which presents the mean predicted completion hours for chart and control groups, along with t-test results, shows that there were no significant differences between chart and control group predicted times for any school. This outcome indicates that the two groups were equivalent in each school and that the actual completion times could also be analyzed using the t-test. These results, also provided in Table 5, reveal that chart students in all four schools completed actual training in a numerically shorter time than control students, with the difference being significant for two schools. The average difference between chart and control actual completion times was over 14 hours, which is more than 2 CMI training days.

Table 5

Mean Predicted and Actual Course Completion Times for Chart and Control Groups--Experiment II

School	Mean Completion Time (Hrs)				Mean Difference (Control-Chart)	t-test Result
	Chart	(N)	Control	(N)		
Predicted						
BE/E Great Lakes	205	(58)	207	(99)	2	0.21
BE/E, Memphis	150	(199)	152	(268)	2	0.79
Propulsion Engineering	109	(191)	113	(176)	4	1.47
Radioman "A"	209	(120)	205	(114)	-4	0.99
Completed						
BE/E, Great Lakes	172	(58)	195	(99)	23	1.96
BE/E, Memphis	128	(199)	137	(268)	9	2.01*
Propulsion Engineering	95	(191)	104	(176)	9	2.55*
Radioman "A"	196	(120)	214	(114)	18	1.84

*$p < .05$.

Attitudes

Eighty percent (23) of the 29 instructors responding to the questionnaire felt that the charts were useful in helping the students complete the course efficiently. Over 72 percent indicated that they would like to have the charts available to them when they manage another CMI course. Fifty-seven percent of the instructors and 80 percent of the students agreed that the students would volunteer for extra study to keep their PR down.

DISCUSSION AND CONCLUSIONS

Although course completion data alone from Experiment I do not support the efficacy of the chart procedures, other factors entered into the decision to conduct the operational evaluation in Experiment II. The strong support from both students and instructors for the chart procedures and the sizable potential savings in reduced training time if the chart procedures were effective were sufficient reasons to proceed with the operational test in Experiment II. The best chart method appeared to involve students requesting charts that have indications of available incentives.

Experiment II amounts to four independent replications of the chart experiment, using as a chart procedure the Chart on Demand with Incentive condition. In all cases, with four different schools and management styles, the chart procedures did yield reduced training time. The procedures were of sufficient benefit that, after termination of data collection, three schools continued to use the charts. It is not possible from Experiment II to tell whether the reduced training time was a result of the student charts, the instructor charts, or all charts in combination. It is clear, however, that the chart procedures bring both the students and instructors into closer contact with the actual progress of the student so that training time reductions occur. Apparently, the students are made more aware of their use of training time and consequently spend the time more judiciously. Regardless, the net effect in this case was to reduce training time on an average of 1 to 3 training days. This finding replicates that found by McCombs, Dobrovolny, and Judd (1979) in an Air Force CMI system and extends the generality of the charting procedures to another instructional setting.

For this operational test, it was necessary to install an additional GE terminet in each complex in order to generate the charts. This would not be operationally practical. MIISA personnel have advised that computer software modifications could eliminate the need for the extra terminets. In view of the need for software modification, any chart procedure implementation decision should be made in conjunction with decisions regarding any other planned upgrade of the CMI system.

RECOMMENDATIONS

It is recommended that the Chief of Naval Education and Training (1) implement the incentive chart procedures into CMI courses as a part of any effort to upgrade the CMI system, and (2) investigate the feasibility of establishing a special service ribbon to be used as an incentive for superior training accomplishment.

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APPENDIX

INSTRUCTIONS PROVIDED IN NAVPERSRANDCEN FEEDBACK STUDY

PRELIMINARY INSTRUCTIONS TO STUDENTS

Welcome to Basic Electronics and Electricity! As you know, you are beginning the course that is fundamental to many of the advanced training opportunities that probably attracted you to the Navy in the first place. You are certainly aware of how important it is to you that you do well in this course.

Basic Electronics and Electricity is one of the courses taught by the Navy's computer-managed instruction (CMI) system. The Navy's CMI system is the biggest, and probably the best, in the world today. Thousands of successful graduates of BE/E report that they especially like the individualized aspect of the CMI system.

No system is perfect, not even the Navy CMI system. For that reason, the Navy Personnel Research and Development Center in San Diego has had a team of researchers studying the CMI system for several years. We are part of that team and we are working in the center you are assigned to. We are conducting a study to see if certain kinds of feedback help students learn the material better and/or faster. We would like very much for you to participate in our study, particularly since almost everyone else in the center will be participating. We can assure you that we will not ask you to do anything that would impede your performance in BE/E; in fact, we think you will be helped by participating. Here is all you will have to do to participate:

1. Read and sign the accompanying form. In order for us to use your data for research purposes, we must have your signed permission. Your privacy will be completely protected! Our little computer is no smarter than the Navy's big computer and it really doesn't care who you are, only how well you are doing.

2. Give the signed form to one of us so we can enter you into our little computer. We'll be easy to find--sitting at the front of the center, near the terminet.

3. Each time you have a transaction with the CMI computer and receive a message from the terminet, bring it by our table so one of us can enter the data we need into our little computer. We will immediately return your message to you so you can file it with the others. This step is <u>very</u> important; to help you remember, we will have at our table the hole punch you need to put your transaction slip into your file. Just find the hole punch and you'll find us!

That's all you have to do for now--sign the form, sign up, and remember to stop by our table each time you go to the terminet. After you have completed about ten modules or so, we will give you some additional instructions about the feedback you will be receiving during the remainder of the course. If you have <u>any</u> questions at all about this, one of us will be happy to try to answer them for you.

Remember, your participation is important! Help us try to make BE/E even better than it is now.

NAVPERSRANDCEN Research Team

Bill Hartman
Linda Ward
Brian Brett
Hank Pennypacker

PHASE II INSTRUCTIONS TO STUDENTS

Congratulations! You are now between one quarter and one third of the way through BE/E. You are no doubt completely familiar with how the CMI system works and how we are gathering data. From here on, as we promised in the preliminary instructions, we will be providing some useful (we hope) information to you.

You have just received a Progress Evaluation Chart (PEC) from our little computer. This chart gives you a picture of your progress in BE/E as of this date. Here is what you need to know to interpret your chart:

1. The horizontal axis represents the 32 BE/E computer modules in the order you will take them.

2. The vertical axis is called Progress Rate. Here is how it is calculated. Based on the experience of hundreds of other students who have taken BE/E, the Navy computer makes a prediction as to how long you should take to complete each module. Of course it also knows how long you actually take to complete each module, so it can tell whether you are ahead or behind of where it thinks you should be. It makes this calculation each time you begin and finish a module.

3. Each little symbol on your chart shows how your actual progress compares to your predicted progress up to that point in the course. The Progress Rate is the total actual time divided by the total predicted time, so if you are ahead of schedule, your symbols will be below the 1.0 line. If you are behind schedule, your symbol will be above the 1.0 line. For example, suppose that your symbol for Module 8 is at 1.20. This would mean that, after completing 8 modules, you had used 20 percent more time than the computer predicted you would. But, suppose that after Module 10, your symbol is down to 0.90. That means you picked up speed on Modules 9 and 10 so that you are now 10 percent ahead of schedule.

The reason we are giving you these charts is to let you monitor your own progress. This will help you avoid unpleasant things like assigned extra study time or having to talk to an Academic Board. Even better, the Navy has some special rewards for people who do much better than predicted, and we think progress charts may help more students earn those bonuses. More about that later. For now, you should try to make your symbols go as low as possible on the chart. The way to do this is to work rapidly but carefully on each module so you will beat your predicted time. Don't work too fast and get sloppy, or you will lose more time than you gain by having to take too many remedial tests.

In order to help you keep track of your progress, we will be giving you:

- An up-to-date chart like this every time you complete a module (Group CC).
- The information you need to plot your own Progress Rate on the chart (Group CS).
- An up-to-date chart like this at various times throughout the remainder of the co[illegible] (Group CY).
- An up-to-date chart like this WHENEVER YOU ASK US FOR ONE (Group CD).

In addition, we will be giving you your predicted times for each module so you will be better able to plan your work time and bring your chart down.

You may notice that other students in the center are receiving feedback more or less often than you. That is because we are trying to determine whether these types of feedback help students and if so, under what conditions they help the most. To do this, we have to have some variation in the schedule and type of feedback given.

If you have any questions at all, or need help interpreting your chart, just ask any of us. Don't forget to keep coming by our table each time you have a transaction at the terminet so we can keep our little computer up to date and give you accurate feedback!

NAVPERSRANDCEN Research Team

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PROGRESS RATE PLOTTING GUIDE

In order to help you keep track of your progress, we are giving you your current progress rate every time you complete a module. You should plot this number on your Progress Evaluation Chart (PEC) in order to see how your progress has changed since last time. Graphing on the PEC is easy and quick. Just follow these steps:

1. On the horizontal axis, read across until you find the module number you have just completed.

2. In the same manner, locate your current progress rate on the vertical axis.

3. From the module number located in Step 1, move perpendicularly up the chart to a point directly across from the value on the vertical axis that corresponds to your current progress rate.

4. Place a dot on the spot located in Step 3. The dot should be directly over the module number you just completed and straight across from the progress rate value equal to your current progress rate.

Be sure to graph your new progress rate as soon as you complete a module so you will have a complete up-to-date picture of your progress through the course.

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